about 80,000 years ago. But Professor Geikie shows that man, using paleolithic or rough stone implements, was living in France and southern England during this last glacial epoch. When the latest ice departed, permitting men to extend north over Scotland and north-western Europe, they had already reached their neolithic stage, using smoothly ground and polished stone implements.

The alternative theory of the cause of the accumulation of ice-sheets, which is held by Dana, Upham, and LeConte, ascribing the cold climate to elevation of the glaciated areas as high plateaus, so that they would receive snowfall during the greater part of the year, seems to Professor Geikie very improbable, and a large portion of his last lecture was devoted to its refutation. This explanation, however, would accord with the estimates of the length of post-glacial time before noticed, and would seem more consistent with the probable antiquity of man, and with his known rate of development of skill in the manufacture of implements and in all the useful arts.

TREATMENT OF FUNGOUS DISEASES.[1]

THAT many of the most destructive diseases of cultivated plants can be and are every year almost completely controlled, is a fact perfectly well known to those who are familiar with the subject; but it has as yet come to be realized by very few, relatively, of those to whom it is of the greatest importance,— farmers, gardeners, fruit-growers, florists, amateurs, and others.

The practicability and great money value of proper treatment in the case of various plant-diseases, which, in the absence of such treatment, would reduce the yield of important crops to almost nothing, have already become apparent to some cultivators who have been progressive enough to try for themselves, or who live near the experimental fields or orchards of experiment stations, or of progressive neighbors. The vast majority, however, of those who should be most interested have been heretofore too indifferent or too sceptical even to investigate the basis of the very strong and positive statements which have been made concerning the efficacy of preventive treatment for fungous diseases of plants.

From the nature of parasitic fungi, and the fact that they are for the most part parasites within the tissues of their hosts, it is evident that our efforts must be directed toward preventing their attacks. The present state of our knowledge does not enable us to stop the development of a parasite within its host-plant, without injury to the host, after it has once obtained a foothold.

The various forms of preventive treatment for a given disease fall naturally under two heads,— field and orchard hygiene, and individual protection. The former includes the minimizing of all sources of infection by the removal of rubbish, of remains of diseased plants or fruits, or of wild plants which may serve as propagators of the disease. The latter includes the application to the plants to be protected of substances in liquid or solid form which shall fortify them against the attacks of fungi which cause disease. Such substances are known as "fungicides." Since different fungi attack their hosts in very different ways, since their modes of development and the effects which they produce differ widely, it is plain that no all-embracing rule can be laid down for the treatment of fungous diseases. Certain principles of general applicability can, however, be stated, certain general directions can be given, and instructions regarding the preparation and application of those fungicides which have been proved to be most useful and effective can be furnished.

There are definite laws of health for plants as well as for animals; and in one case, as in the other, neglect of those laws invites disease. In the first place, plants which are expected to grow and thrive must be furnished with an abundance of the materials necessary to growth. Weak, poorly nourished plants suffer the attacks of parasites of all sorts, and have no power to resist them. Second, where a crop has suffered from a fungous disease in one season, and a good crop of the same kind is desired in the following season, every tangible trace of the disease must be removed. For example: if a vineyard has suffered from mildew or black rot, all diseased leaves and berries should be collected at the end of the season with scrupulous care, and wholly burned; and the same advice applies to a large list of cases. Thus incalculable numbers of the spores of the fungi of the respective diseases will be prevented from infesting the next season's crop. In some cases where the spores remain in the soil, as in the stump-foot of cabbages or the smut of onions, the attacks of the disease can only be avoided by rotation with crops upon which the fungus in question cannot live. Third, wild plants, which, being nearly related to a given cultivated one, may be subject to the same disease, or which bear a complementary spore-form of a pleomorphic fungus, should be carefully excluded from the neighborhood of cultivated ones. Thus, wild cherries or plums, which are equally subject to the black-knot, should be kept away from plum-orchards, and spinach-fields should be kept free of pig-weed, since both plants are attacked by the same mildew; and again, since red cedars bear one spore form of a fungus whose other form is the rust of apple-leaves, it is plain that they should not be allowed to grow near an apple-orchard.

Now, when the general hygienic conditions have been made as unfavorable as possible to the development of disease, we may resort finally to the special protection afforded by the use of fungicides.

These preparations, when properly prepared and when applied at the right times and in the right way, have been abundantly proved to be of the greatest value, and often to determine the difference between a full crop from plants on which they are used and practically no crop where they are not applied.

But the fact cannot be too strongly emphasized that every thing depends upon how they are prepared, and upon how and when they are applied. The bulletin gives somewhat full instruction how to prepare and apply the most valuable fungicides, and such general hints when to apply them as will be of service. The proper times for their application vary so much with special conditions, however, that instructions on this point must form an important part of the special directions for any particular case.

The protective quality of most of the best fungicides lies in the fact that they contain a certain proportion of copper; and, of the four recommended as applicable to most cases of fungous diseases, three contain it as the essential constituent.

The Bordeaux mixture requires six pounds of sulphate of copper, four pounds of quicklime (fresh), and twenty-two gallons of water.

The sulphate of copper, known to the trade also as blue vitriol or blue-stone, is dissolved in two gallons of water. The solution will be hastened if the water be heated and the sulphate pulverized. After the solution is complete, fourteen gallons of water are added to it. The quicklime is slaked in six gallons of water, and stirred thoroughly until it forms a smooth, even mixture. After standing for a short time, it is again stirred, and added gradually to the sulphate solution, which is thoroughly stirred meanwhile. The mixture is then ready for use, though some experimenters recommend further dilution to twenty-five or thirty gallons for certain uses. It should not be prepared until needed, and should be used fresh, as it deteriorates with keeping. Since the lime remains merely in suspension, and is not dissolved, the mixture should be strained through fine gauze before entering the tank of the spraying-machine, so that all of the larger particles which might clog the sprayer may be removed.

Ammoniacal carbonate of copper, in its improved form, is prepared from three ounces of carbonate of copper, one pound of carbonate of ammonia, and fifty gallons of water.

Mix the carbonate of copper with the carbonate of ammonia, pulverized, and dissolve the mixture in two quarts of hot water. When they are wholly dissolved, add the solution to enough water to make the whole quantity fifty gallons. This preparation has been found to be better and cheaper than that made according to the original formula, which is as follows :—

Dissolve three ounces carbonate of copper in one quart *aqua*

[1] Abstract of Bulletin No. 39 of the Massachusetts State Agricultural Experiment Station, for April, 1891, by James Ellis Humphrey.

ammonia (22° B.), and add the solution to twenty-five gallons of water.

Dr. Thaxter of the Connecticut Experiment Station suggests that a very large saving may be made by preparing the carbonate of copper by the following method, instead of buying it, as its market price is much greater than that of the materials necessary for its preparation. Take two pounds of sulphate of copper and dissolve it in a large quantity of hot water; in another barrel or tub dissolve two and one-half pounds of carbonate of soda (sal soda) in hot water. When both are dissolved and cooled, pour the soda solution into the copper solution, stirring rapidly. There will result a blue-green precipitate of carbonate of copper, which must be allowed to settle to the bottom of the vessel. Now draw off the clear liquid above the sediment, fill the vessel with fresh water, and stir up the contents thoroughly. After the copper carbonate has once more settled to the bottom, again draw off the clear fluid above. The carbonate may now be removed from the vessel and dried, when it is ready for use. From the amount of blue-stone and sal soda given above will be produced one pound of copper carbonate, and the amount of each necessary to produce any given amount of copper carbonate is easily calculated.

Sulphate of copper is used in solutions of varying strength for certain special cases.

Sulphide of potassium, known also as sulphuret of potassium or liver of sulphur, has been found useful in the treatment of diseases caused by those fungi known as "powdery mildews," especially on plants grown under glass. It is ordinarily used in the proportion of half an onuce of the sulphide to one gallon of water.

The one of the above fungicides chosen as most available under existing conditions is now to be applied to the plants which it is desired to protect against disease. In the special case of the grain smuts, the only effectual treatment is that applied to the seed-grain, since these fungi depend for their propagation upon the spores which adhere to the grain and germinate with it. They cannot attack the host-plant after it has fairly passed the seedling stage, and the adhering spores may be killed before planting without injury to the seed. But ordinarily the fungicide must be thoroughly applied to the whole of each growing plant in the form of a fine spray, so that the plant is completely wet, but not flooded. Perhaps a practical measure of the proper amount of a fungicide to be applied to a plant may be obtained by stopping as soon as the plant is wholly wet, and before the solution begins to drip from it. In order to insure a fine and even spray and economy of materials, especial care should be used in securing proper nozzles. The ordinary spraying-nozzles used with hose or with small hand-pumps are utterly unsuited to this purpose.

As has been said, the question when to apply is of the first importance in dealing with any disease, but the answer varies with the case in hand. In general, however, let it be remembered that all treatment is preventive, that plants once attacked are lost, and that spraying must therefore be prompt and early. In the case of a disease of an herbaceous crop like potatoes, the first spraying should be given at once on the appearance of the disease in any part of the field or in a neighboring field. The same applies to diseases of woody plants, which have previously been free from disease; but where grapes or apples, for instance, were attacked last year, treatment should begin with the beginning of growth, and should proceed on the assumption that the disease will reappear if not prevented. In any case, after spraying is begun, it must be repeated until danger is past (a very variable period) at intervals which may average ten days or two weeks, but will vary according to circumstances, depending especially on the amount of rainfall, which washes the copper salts from the plants, and renders a new application necessary. It is always best to leave an occasional plant or row of plants untreated among the treated ones, to furnish a basis for judgment as to the efficacy of the treatment.

It is earnestly hoped that many persons in the State who have suffered in the past from fungous diseases will this year undertake definite measures to avoid such losses, and will communicate early their intention to do so to the station.

SCHOOL OF APPLIED ETHICS, SUMMER SESSION.[1]

BEGINNING early in July, and continuing six weeks, there will be held at some convenient summer resort in New England or New York a school for the discussion of ethics and other subjects of a kindred nature. The matter to be presented has been selected with regard to the wants of clergymen, teachers, journalists, philanthropists, and others who are now seeking careful information upon the great themes of ethical sociology. It is believed that many collegiate and general students will also be attracted by the programme. Speakers and subjects will be, so far as arranged, as follows: —

I. Department of Economics, in charge of Professor H. C. Adams, Ph.D., of the University of Michigan.

Professor Adams will deliver eighteen lectures (three during each of the six weeks) on the history of industrial society in England and America, beginning with the middle ages, and tracing genetically the gradual rise of those conditions in the labor world which cause so much anxiety and discussion to-day.

Along with this main course will be presented (1) three lectures by President E. Benjamin Andrews, — one on the evils of our present industrial system, one on socialism as a remedy, and one on the better way; (2) three lectures by Professor Frank W. Taussig, Ph.D., — one on distributive and credit co-operation, one on productive co-operation and profit-sharing, and one on workingmen's insurance; (3) three lectures by Hon. Carroll D. Wright on factory legislation; (4) three lectures by Professor J. B. Clark, Ph.D., on agrarian questions, discussing rent and tenure, and considering the agrarian element in the farmers' alliance movement; (5) three lectures by Albert Shaw, Ph.D., — one on the housing of the poor in Paris, one on the housing of the poor in London, and one on Gen. Booth's scheme for relieving poverty (the first two of these lectures will have especial reference to the question of rapid-transit facilities in cities); (6) three lectures by Professor E. J. James, Ph.D., on labor and iudustrial legislation in Europe.

In addition to the above, two lectures are expected from Mr. Henry D. Lloyd of Chicago, giving chapters in the industrial history of the United States.

If there be sufficient demand for it, special instruction in the principles of economics will be provided.

II. Department of the History of Religions, in charge of Professor C. H. Toy, D.D., of Harvard University.

Professor Toy will offer a general course of eighteen lectures, extending through the six weeks, treating the history, aims, and method of the science of history of religions, and illustrating its principles by studies in the laws of religious progress, with examples drawn from the chief ancient religions. Among the topics will be the classification of religions, conceptions of the Deity, religion and superstition, sacrifice and the priesthood, the idea of sin, religion and philosophy, religion and ethics, sacred books, religious reformers and founders.

The provisional scheme for the special courses is as follows: "Buddhism," Professor M. Bloomfield, Johns Hopkins University; "The Babylonian-Assyrian Religion," Professor M. Jastrow, University of Pennsylvania; "Mazdeism," not yet provided for; "Islam," Professor G. F. Moore, Andover Theological Seminary; "The Greek Religion," not yet provided for; "The Old Norse Religion," Professor G. L. Kittredge, Harvard University.

It is hoped also to arrange a set of Sunday-evening lectures, in which the positions of various religious bodies, Catholic, Protestant, and Jewish, will be expounded by prominent members of these bodies.

III. Department of Ethics, in charge of Professor Felix Adler, Ph.D., of New York.

Professor Adler will offer a general course of eighteen lectures, extending through the six weeks, on the system of applied ethics, including a brief survey of the various schemes of classification adopted in ancient and modern ethical systems, the discussion of the relation of religious to moral instruction, of the development of the conscience in the child, etc. The scheme of duties treated will embrace personal ethics, social ethics in general, the ethics of

[1] From April number, International Journal of Ethics.